

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 10-308596

(43)Date of publication of application : 17.11.1998

(51)Int.Cl.

H05K 9/00

H01F 1/00

(21)Application number : 09-134397

(71)Applicant : NIPPON TELEGR & TELEPH CORP
<NTT>

(22)Date of filing : 07.05.1997

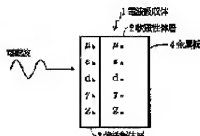
(72)Inventor : MIYATA SHIGEMORI
MATSUMOTO MORIHIKO
TAKAZAWA HISAYOSHI

(54) RADIO WAVE ABSORBENT

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a thin radio wave absorbent of about 2 mm in thickness which can simply adjust a matching frequency without changing material, although radio wave absorbent which is used in a VHF band and a UHF band has been applied only to a radio wave dark room and the outer wall of a high building, because it is thick, 6-8 mm in thickness, heavy, and expensive.

SOLUTION: Radio wave absorbent 1 has a lamination structure constituted of the following in order from the incident side of a radio wave; a ferroelectric layer 3 such as barium titanate, a carbonyl iron based soft magnetic material layer 2, and a metal plate 4 as a short-circuit layer. Symbols μ , ϵ , d , γ and Z show complex permeability, complex permittivity, thickness, propagation constant, and characteristic impedance, respectively. A suffix (a) shows the soft magnetic material layer 2, and a suffix (b) shows the



ferroelectric layer 3.

* NOTICES *

JPO and INPIT are not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.*** shows the word which can not be translated.

3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1] A wave absorber which are a VHF band and an object for UHF bands, and is characterized by having the laminated structure which provided a ferroelectric layer, a soft magnetic material layer, and a short circuited layer sequentially from the incidence side of electromagnetic waves.

[Claim 2] The wave absorber according to claim 1 having used pitch powder material of a sintered compact of barium titanate, or said barium titanate for said ferroelectric layer, and using a carbonyl iron grain child's pitch powder material for said soft magnetic material layer 50 to 95%.

[Claim 3] The wave absorber according to claim 1 which carries out having used a 50 to 95% carbonyl iron grain child's 1.0-4.0-mm-thick pitch powder material to said ferroelectric layer with the feature at a sintered compact of 0.1-1.5-mm-thick barium titanate or pitch powder material of said barium titanate, and said soft magnetic material layer.

[Claim 4] The wave absorber according to claim 1 having used pitch powder material of a sintered compact of barium titanate, or said barium titanate for said ferroelectric layer, and using a sintered compact of a ferrite, or pitch powder material of said ferrite for said soft magnetic material layer.

[Claim 5] Pitch powder material of a sintered compact of 0.1-1.5-mm-thick barium titanate, or said barium titanate to said ferroelectric layer, The wave absorber according to claim 1 using 4.0-10.0-mm-thick a sintered compact of said ferrite or pitch powder material of a ferrite for said soft magnetic material layer.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the wave absorber used in a VHF band (30 MHz - 300 MHz) and a UHF band (300 MHz - 3 GHz).

[0002]

[Description of the Prior Art] The absorber of the electric wave currently used in the frequency band above-mentioned now is a complex which distributed the sintered compact and this powder of the cubic ferrite in resin. These sintered compacts and complexes were as thick as 6-8 mm, and heavily, since it was expensive, the application place was restricted to the anechoic chamber, the outer wall of the skyscraper, etc. Although about 2 mm and comparison book **** were developed for thickness, as for the complex which distributed carbonyl iron in polymer resin, application frequency was restricted to a not less than 4-GHz thing. In order to obtain the absorber with which consistency frequency differs since the consistency frequency from which the return loss of an absorber serves as the maximum is decided by construction material, the point that it is necessary to change construction material is also pointed out as another technical problem. These reasons are explained below.

[0003] When the absorber of an electric wave is used for a rear face, having connected too hastily with the metal plate, the absorbed remaining electromagnetic waves are reflected and it becomes a rule of thumb of

the performance of the absorber of an electric wave that this reflectance is small. The reflectance γ of the electromagnetic waves which entered vertically is $\gamma = (Z_e - Z_0) / (Z_e + Z_0)$. (1) $Z_e = Z_0 \tanh(\gamma d)$. It is given by (2). Z_e is the impedance measured toward the direction of a metal plate from the surface of the absorber, and Z_0 , γ , d are a characteristic impedance of an absorber, a propagation coefficient, and thickness here, respectively. Z_0 is a vacuous characteristic impedance. The return loss R is $R = 20 \log(\gamma)$. It defines as (3). A characteristic impedance and a propagation coefficient set angular frequency of electromagnetic waves to ω , and there is the following relation to complex dielectric constant ϵ of an absorber and complex-magnetic-permeability μ . $\gamma = \omega(\mu \epsilon)^{1/2}$ (4) $Z_0 = (\mu_0 / \epsilon_0)^{1/2}$ (5) from the formula of these. In order to obtain the thin absorber of an electric wave with small matching thickness from which return loss serves as the maximum, it is understood in γ that it is advantageous to use material with big amplitude permeability and dielectric constant greatly therefore.

[0004] Drawing 6 is a frequency characteristic figure of relative permeability showing the limit (for example, physics of a *****ferromagnetic: ***** 1991) of Snoek in a cubic ferrite. Since amplitude permeability decreased so that it is bound to the limit of Snoek and becomes high frequency, as shown in a figure, when the above-mentioned cubic ferrite was used about amplitude permeability, an absorber of 6 mm or less was not able to be developed. The frequency dispersion of the amplitude permeability of this cubic ferrite can be approximated with a following formula.

$\mu(f) = \mu_0 (1 + K / (1 + jf/f_c))$ (6) $K = \mu_1 / \mu_0 - 1$ (7) μ_1 and μ_0 are initial permeability and the amplitude permeability in a vacuum here, respectively. When determining ***** of an absorber, an important parameter is the product S of K and f_c in the above-mentioned formula ($= K f_c$).

[0005] Drawing 7 shows the result of having asked for the relation between consistency thickness and initial permeability by calculation. It is hardly dependent on initial permeability, and consistency thickness is mostly decided with the parameter S , and has such low consistency frequency that initial permeability is large. In a cubic ferrite, the value of this S is about 6 GHz, and is 8 mm which the consistency thickness decided from this value described previously. Since S has a value which is 20 to about 30 in the limit of Snoek with the material of a carbonyl iron system which is not restrained, a consistency thickness of 2 mm or less becomes possible. However, since initial permeability was obtained only for an 8 or less-about thing, the material of a carbonyl iron system had high consistency frequency, and similarly a thin absorber was not able to be provided in a frequency domain of several gigahertz or less.

[0006] Drawing 8 is a characteristic figure showing the thickness dependency of return loss frequency dispersion. If the return loss R is dependent on the thickness of an absorber and thickness changes as shown in a figure, the frequency and the maximal value from which R becomes the maximum will change. However, the thickness (consistency thickness) which gives R big enough is restricted, therefore the frequency at that time (consistency frequency) was also restricted. In order to obtain the absorber with which consistency frequency differs, it is necessary to change the construction material of an absorber.

[0007]

[Problem(s) to be Solved by the Invention] This invention is made in view of the above, and is a thing. The purpose is to provide the wave absorber for a VHF band and UHF bands which enabled it to adjust consistency frequency simple, without changing construction material also including the absorber of

lowering the consistency frequency of a thin carbonyl iron system material, and enabling application on lower frequency, and a cubic ferrite series.

[0008]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, a wave absorber of this invention makes it a gist to have the structure where an absorber and ferroelectrics, such as barium titanate, which are used from the former, such as a soft magnetic material or a cubic ferrite soft magnetic material of a carbonyl iron system, were made to laminate.

[0009]

[Embodiment of the Invention] In order to solve an aforementioned problem the wave absorber of this invention, Are a VHF band and an object for UHF bands, and sequentially from the incidence side of electromagnetic waves A ferroelectric layer, Have the feature to have the laminated structure which provided the soft magnetic material layer and the short circuited layer, and to said ferroelectric layer the pitch powder material of the sintered compact of barium titanate, or said barium titanate, It has the feature to have used the carbonyl iron grain child's pitch powder material for said soft magnetic material layer 50 to 95%, The sintered compact of 0.1–1.5-mm-thick barium titanate [said ferroelectric layer], or the pitch powder material of said barium titanate, It has the feature to have used the 50 to 95% carbonyl iron grain child's 1.0–4.0-mm-thick pitch powder material for said soft magnetic material layer, To said ferroelectric layer, the pitch powder material of the sintered compact of barium titanate, or said barium titanate, It has the feature to have used the sintered compact of a ferrite, or the pitch powder material of said ferrite for said soft magnetic material layer, It has the feature to have used 4.0–10.0-mm-thick the sintered compact of said ferrite or the pitch powder material of a ferrite said soft magnetic material layer for said ferroelectric layer. [material / of the sintered compact of 0.1–1.5-mm-thick barium titanate, or said barium titanate / pitch powder]

[0010]

[Example] Hereafter, one example of this invention is described based on a drawing. Drawing 1 is structural drawing showing the most fundamental structure of the wave absorber of this invention. As for a wave absorber and 2, in a figure, a ferroelectric layer and 4 are the metal plates as a short circuited layer a soft magnetic material layer and 3 1. In the wave absorber 1 of the structure shown in a figure, the impedance shown in the formula 2 is rewritten like a following formula.

$$Z_A = (Z_a \tanh(\gamma_a d_a) + Z_b \tanh(\gamma_b d_b)) / (1 + (Z_a / Z_b) \tanh(\gamma_a d_a) \tanh(\gamma_b d_b)) \quad (8)$$

Here Z_a , γ_a and d_a — the characteristic impedance of the soft magnetic material layer 2, and a propagation coefficient — and thick — come out and it is — Z_b , γ_b , and d_b — the characteristic impedance of the ferroelectric layer 3, and a propagation coefficient — and thick — it comes out. As a result, consistency frequency and consistency thickness serve as a different value for a while from the case of a soft magnetic material simple substance.

[0011] Drawing 2 is a frequency characteristic figure of return loss showing the simulation result of the return loss frequency dispersion in the wave absorber of this invention. A figure shows one example of the result of having asked for the frequency dispersion of the return loss of the wave absorber 1 by calculation. The amplitude permeability of the soft magnetic material layer 2 and a dielectric constant were calculated using the value of the material (with initial permeability 8.0, consistency 1.5 mm in thickness, and a

consistency frequency of 4.1 GHz material) of a carbonyl iron system. The ferroelectric layer 3 was used as the material of the relative permeability 1 and the specific inductive capacity 500. Consistency frequency becomes low as the thickness of the ferroelectric layer 3 increases. That is, in this example, the thickness of the ferroelectric layer 3 serves as consistency frequency of 1.8 GHz in 0.1 mm, and serves as consistency frequency of 900 MHz in 0.5 mm. The thickness of the soft magnetic material layer 2 which gives a match condition is the same value as the consistency thickness at the time of hardly changing, even if the ferroelectric layer 3 was added, but using it alone.

[0012]Drawing 3 is a figure showing the dielectric constant and thickness dependency of a ferroelectric of change of consistency frequency in the wave absorber of this invention. The thickness of the ferroelectric layer 3 required as shown in a figure, in order for the drop width of consistency frequency to become so large that the thickness or the dielectric constant of the ferroelectric layer 3 is large and to obtain the drop width of the same consistency frequency is in inverse proportion to the dielectric constant. This shows that the value of consistency frequency can be adjusted easily by changing the thickness of the ferroelectric layer 3.

[0013][Example 1] Drawing 4 is a characteristic figure in the 1st example of this invention which comprised 1.5-mm carbonyl iron rubber and 0.5 mm of barium titanate. 1.5-mm 50 to 95% carbonyl iron rubber is used as the soft magnetic material layer 2. In a figure, A of a black dot seal shows the return loss of the wave absorber constituted using the sintered compact of 0.5 mm of barium titanate as the ferroelectric layer 3. In the same 900 MHz as a calculation result, return loss of 29 dB is obtained and it became possible to realize a 2-mm-thick wave absorber in a UHF band. In the case of pitch powder material 0.5mm, the solid line B is the characteristic in case there is no white round mark C of three ferroelectric layer. As the soft magnetic material layer 2, 50 to 95% carbonyl iron rubber and a barium titanate sintered compact may be sufficient, or the pitch powder material may be sufficient.

[0014][Example 2] Drawing 5 is a characteristic figure in the 2nd example of this invention which comprised a ferrite and barium titanate. The return loss at the time of making the sintered compact of barium titanate laminate is shown in the wave absorber of a ferrite sintered compact. Even if it used the sintered compact of the same ferrite, the wave absorber of various consistency frequency was obtained only by changing the thickness of a barium titanate sintered compact. A ferrite sintered compact and the sintered compact of barium titanate may be sufficient, and the pitch powder material may be sufficient.

[0015]

[Effect of the Invention]As explained above, the wave absorber by this invention, Since it was considered as the laminated structure which provided the ferroelectric layer, the soft magnetic material layer, and the short circuited layer sequentially from the incidence side of electromagnetic waves, The consistency frequency of a carbonyl iron system material with thin consistency thickness is lowered, application on lower frequency is enabled, and the wave absorber for a VHF band and UHF bands which enabled it to adjust consistency frequency simple can be provided, without changing construction material also including the absorber of a cubic ferrite series.

[Brief Description of the Drawings]

[Drawing 1]It is structural drawing showing the most fundamental structure of the wave absorber of this invention.

[Drawing 2] It is a frequency characteristic figure of return loss showing the simulation result of the return loss frequency dispersion in the wave absorber of this invention.

[Drawing 3] It is a characteristic figure showing the dielectric constant and thickness dependency of a ferroelectric of change of consistency frequency in the wave absorber of this invention.

[Drawing 4] It is a characteristic figure in the 1st example of this invention which comprised 1.5-mm carbonyl iron rubber and 0.5 mm of barium titanate.

[Drawing 5] It is a characteristic figure in the 2nd example of this invention which comprised a ferrite and barium titanate.

[Drawing 6] It is a frequency characteristic figure of relative permeability showing the limit of Snoek in a cubic ferrite.

[Drawing 7] They are consistency thickness and consistency frequency and initial permeability, and a characteristic figure showing a relation with the parameter S.

[Drawing 8] It is a characteristic figure showing the thickness dependency of return loss frequency dispersion.

[Description of Notations]

1 Wave absorber

2 Soft magnetic material layer

3 Ferroelectric layer

4 Metal plate

The complex dielectric constant of ϵ_s soft magnetic material layer

The complex dielectric constant of ϵ_f ferroelectric layer

γ Reflectance of electromagnetic waves

The propagation coefficient of γ_s soft magnetic material layer

The propagation coefficient of γ_f ferroelectric layer

The propagation coefficient of γ_a absorber

Amplitude permeability in μ_0 vacuum

μ_i initial permeability

Complex magnetic permeability of μ_s soft magnetic material layer

Complex magnetic permeability of μ_f ferroelectric layer

Thickness of d_s soft magnetic material layer

Thickness of d_f soft magnetic material layer

Thickness of d_a absorber

R Return loss

The characteristic impedance of Z_0 vacuum

Impedance of Z_A absorber

The characteristic impedance of Z_s soft magnetic material layer

The characteristic impedance of Z_f ferroelectric layer

Impedance of Z_e absorber

The characteristic impedance of Z_a absorber

[Translation done.]

(19) 日本国特許庁 (J P)

(12) 公開特許公報 (A)

(11) 特許出願公開番号

特開平10-308596

(43) 公開日 平成10年(1998)11月17日

(51) Int.Cl.⁶

H 0 5 K 9/00

H 0 1 F 1/00

識別記号

F I

H 0 5 K 9/00

H 0 1 F 1/00

W

C

審査請求 未請求 請求項の数 5 F D (全 5 頁)

(21) 出願番号 特願平9-134397

(22) 出願日 平成 9 年 (1997) 5 月 7 日

特許法第30条第1項適用申請有り 1997年3月6日 社団法人電子情報通信学会発行の「1997年電子情報通信学会総大会講演論文集 通信1」に発表

(71) 出願人 000004226

日本電信電話株式会社
東京都新宿区西新宿三丁目19番2号

(72) 発明者 宮田 恵守

東京都新宿区西新宿三丁目19番2号 日本
電信電話株式会社内

(72) 発明者 松本 守彦

東京都新宿区西新宿三丁目19番2号 日本
電信電話株式会社内

(72) 発明者 高沢 壽佳

東京都新宿区西新宿三丁目19番2号 日本
電信電話株式会社内

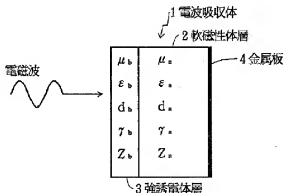
(74) 代理人 弁理士 高山 敏夫 (外1名)

(54) 【発明の名称】 電波吸収体

(57) 【要約】

【課題】 VHF帯及びUHF帯において使用されている電波の吸収体は、6～8mmと厚く、重く、また高価であるためにその適用場所は電波暗室や高層ビルの外壁等に限られていた。厚さが2mm程度と薄く材質を変更すること無く簡便に整合周波数を調整出来るようにした電波吸収体を提供する。

【解決手段】 電波吸収体1は、電磁波の入射側から順にチタン酸バリウム等の強誘電体層3、カルボニル鉄系の軟磁性体層2、短絡層としての金属板4から成る積層構造である。なお、記号 μ 、 ϵ 、 d 、 γ 、 Z は、複素透磁率、複素誘電率、厚さ、伝播定数、特性インピーダ表しており、添字aは軟磁性体層2を、添字bは強誘電体層3を表している。



【特許請求の範囲】

【請求項1】 VHF帯及びUHF帯用であり、電磁波の入射側から順に強誘電体層、軟磁性体層、短絡層を設けた積層構造を有することを特徴とする電波吸収体。

【請求項2】 前記強誘電体層にチタン酸バリウムの焼結体あるいは前記チタン酸バリウムの樹脂分散材を、前記軟磁性体層に50～95%カルボニル鉄粒子の樹脂分散材を用いたことを特徴とする請求項1記載の電波吸収体。

【請求項3】 前記強誘電体層に厚さが0.1～1.5mmのチタン酸バリウムの焼結体あるいは前記チタン酸バリウムの樹脂分散材、前記軟磁性体層に厚さが1.0～4.0mmの50～95%カルボニル鉄粒子の樹脂分散材を用いたことを特徴とする請求項1記載の電波吸収体。

【請求項4】 前記強誘電体層にチタン酸バリウムの焼結体あるいは前記チタン酸バリウムの樹脂分散材を、前記軟磁性体層にフェライトの焼結体あるいは前記フェライトの樹脂分散材を用いたことを特徴とする請求項1記載の電波吸収体。

【請求項5】 前記強誘電体層に厚さが0.1～1.5mmのチタン酸バリウムの焼結体あるいは前記チタン酸バリウムの樹脂分散材を、前記軟磁性体層に厚さが4.0～10.0mmの前記フェライトの焼結体あるいはフェライトの樹脂分散材を用いたことを特徴とする請求項

$$\Gamma = \langle Z_E - Z_0 \rangle / \langle Z_E + Z_0 \rangle \quad (1)$$

$$Z_E = Z_0 \tanh(\gamma_0 d_0) \quad (2)$$

により与えられる。ここで Z_E は吸収体の表面から金属板の方向に向かって測定したインピーダンスであり、 Z_0 、 γ_0 、 d_0 はそれぞれ吸収体の特性インピーダンス

$$R = 20 \log(\Gamma) \quad (3)$$

として定義される。特性インピーダンス及び伝播定数は電磁波の角振動数を ω として、吸収体の複素誘電率

$$\gamma_0 = \omega (\mu_0 \epsilon_0)^{1/2} \quad (4)$$

$$Z_0 = (\mu_0 / \epsilon_0)^{1/2} \quad (5)$$

これらの式から、反射減衰量が最大となる整合厚が小さい電波の薄型吸収体を得るためには、 γ_0 を大きく、従って透磁率や誘電率の大きな材料を使用することが有利であることが理解される。

【0004】図6は、立方晶フェライトにおける S_{noek} の境界（例えば、近角隠信著：強磁性体の物理：学研1991年）を示す比透磁率の周波数特性図であ

$$\mu(f) = \mu_0 \{ 1 + K / (1 + j f / f_r) \} \quad (6)$$

$$K = \mu_1 / \mu_0 - 1 \quad (7)$$

ここで μ_1 、 μ_0 はそれぞれ初透磁率、真空中の透磁率である。吸収体の整合厚さを決定する上で重要なパラメータは前述の式における K と f_r の積 $S (= K \times f_r)$ である。

【0005】図7は整合厚さと初透磁率の関係を計算により求めた結果を示したものである。整合厚さは初透磁

1記載の電波吸収体。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明はVHF帯（30MHz～300MHz）およびUHF帯（300MHz～3GHz）において使用される電波吸収体に関する。

【0002】

【従来の技術】現在上記の周波数帯において使用されている電波の吸収体は、立方晶フェライトの焼結体やこの粉末を樹脂中に分散した複合体である。これらの焼結体や複合体は6～8mmと厚く、重く、また高価であるためにその適用場所は電波暗室や高層ビルの外壁等に限定されていた。また、カルボニル鉄を高分子樹脂中に分散した複合体は、厚さが2mm程度と比較的薄い物が開発されているが、適用周波数が4GHz以上の物に限られていた。また、吸収体の反射減衰量が最大となる整合周波数が材質によって決まるため、整合周波数の異なる吸収体を得るためには材質を変更する必要がある点もまた別の課題として指摘されている。これらの理由を以下に述べる。

【0003】電波の吸収体を裏面を金属板で短絡して使用した場合、吸収された残りの電磁波が反射され、この反射率が小さいことが電波の吸収体の性能の目安となる。垂直に入射した電磁波の反射率 Γ は、

S 、伝播定数、厚さである。また Z_0 は真空の特性インピーダンスである。なお、反射減衰量 R は

ϵ_0 、複素透磁率 μ_0 と次の関係がある。

る。図に示すように S_{noek} の境界に縛られて高周波数になるほど透磁率が減少するため、透磁率に関しては前述の立方晶フェライトを使用する場合、6mm以下の吸収体を開発することはできなかった。この立方晶フェライトの透磁率の周波数分散は次式により近似することが可能である。

率には殆ど依存せずパラメータ S でほぼ決まり、初透磁率 μ_0 が大きいほど低い整合周波数を持つ。この S の値は立方晶フェライトでは6GHz程度であり、この値から決まる整合厚さが先に述べた8mmである。 S_{noek} の境界には制約されないカルボニル鉄系の材料では S が20～30程度の値を持つことから、2mm以下の整合厚さ

が可能となる。しかし、カルボニル鉄系の材料は初透磁率が8程度以下のものしか得られなため整合周波数が高く、数GHz以下の周波数領域では同様に薄い吸収体を提供することはできなかった。

【0006】図8は、反射減衰量周波数分散の厚さ依存性を示す特性図である。図に示すように、反射減衰量は吸収体の厚さに依存しており、厚さが増えるとRが極大となる周波数や極大値が変化する。しかし、十分に大きなRを与える厚さ（整合厚さ）は限られており、従ってその時の周波数（整合周波数）も限られたものになる。整合周波数が異なる吸収体を得るためには、吸収体の材質を変更する必要がある。

【0007】

【発明が解決しようとする課題】本発明は、上記に鑑みてなされたものであり、整合厚さの薄いカルボニル鉄系材料の整合周波数を下げ、より低い周波数での適用を可能にすること、及び立方晶フェライト系の吸収体も含めて、材質を変更すること無く簡単に整合周波数を調整出来るようにしたVHF帯及びUHF帯用の電波吸収体を提供することを目的とする。

【0008】

【課題を解決するための手段】上記目的を達成するため本発明の電波吸収体は、カルボニル鉄系の軟磁性体あるいは立方晶フェライト軟磁性体等従来から用いられている吸収体とチタン酸バリウム等の強誘電体を積層させた構造を有することを要旨とする。

【0009】

$$Z_A = (Z_a \tanh(y_a d_a) + Z_b \tanh(y_b d_b)) / (1 + (Z_a / Z_b) \tanh(y_a d_a) \tanh(y_b d_b)) \quad (8)$$

ここで Z_a 、 y_a および d_a は軟磁性体層2の特性インピーダンス、伝播定数および厚さであり、 Z_b 、 y_b および d_b は強誘電体層3の特性インピーダンス、伝播定数および厚さである。この結果、整合周波数及び整合厚さは軟磁性体単体の場合と少し異なった値となる。

【0011】図2は、本発明の電波吸収体における反射減衰量周波数分散のシミュレーション結果を示す反射減衰量の周波数特性図である。図は電波吸収体1の反射減衰量の周波数分散を計算により求めた結果の1例を示したものである。軟磁性体層2の透磁率、誘電率はカルボニル鉄系の材料（初透磁率8.0、整合厚さ1.5mm、整合周波数4.1GHzの材料）の値を用いて計算した。また、強誘電体層3は比透磁率1.1、比誘電率50.0の材料とした。整合周波数は強誘電体層3の厚さが増加するに従い低くなる。すなわち、この例では強誘電体層3の厚さが0.1mmでは整合周波数1.8GHz、また0.5mmでは整合周波数9.0MHzとなっている。整合条件を与える軟磁性体層2の厚さは、強誘電体層3が加わってもほとんど変化せず、単体で利用した場合の整合厚さと同じ値である。

【0012】図3は、本発明の電波吸収体における整合

【発明の実施の形態】上記課題を解決するために本発明の電波吸収体は、VHF帯及びUHF帯用であり、電磁波の入射側から順に強誘電体層、軟磁性体層、短絡層を設けた積層構造を有することに特徴を有し、前記強誘電体層にチタン酸バリウムの焼結体あるいは前記チタン酸バリウムの樹脂分散材を、前記軟磁性体層に5.0～9.5%カルボニル鉄粒子の樹脂分散材を用いたことに特徴を有し、前記強誘電体層に厚さが0.1～1.5mmのチタン酸バリウムの焼結体あるいは前記チタン酸バリウムの樹脂分散材、前記軟磁性体層に厚さが1.0～4.0mmの5.0～9.5%カルボニル鉄粒子の樹脂分散材を用いたことに特徴を有し、前記強誘電体層にチタン酸バリウムの焼結体あるいは前記チタン酸バリウムの樹脂分散材を、前記軟磁性体層に厚さが0.1～1.5mmのチタン酸バリウムの焼結体あるいは前記チタン酸バリウムの樹脂分散材、前記軟磁性体層に厚さが4.0～10.0mmの前記フェライトの焼結体あるいはフェライトの樹脂分散材を用いたことに特徴を有している。

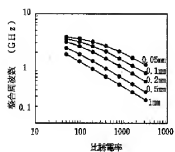
【0010】

【実施例】以下、本発明の一実施例を図面に基いて説明する。図1は、本発明の電波吸収体の最も基本的な構造を示す構造図である。図において、1は電波吸収体、2は軟磁性体層、3は強誘電体層、4は短絡層としての金属板である。図に示す構造の電波吸収体1では式2に示すインピーダンスは次式のように書き換えられる。

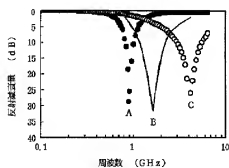
周波数の変化の強誘電体の誘電率及び厚さ依存性を示す図である。図に示すように、整合周波数の低下幅は強誘電体層3の厚さあるいは誘電率が大きいほど大きくなり、同じ整合周波数の低下幅を得るために必要な強誘電体層3の厚さはその誘電率に反比例している。このことは、強誘電体層3の厚さを変えることによって容易に整合周波数の値を調整できることを示している。

【0013】【実施例1】図4は、1.5mmのカルボニル鉄ゴムと0.5mmのチタン酸バリウムで構成された本発明の第1実施例における特性図である。軟磁性体層2として1.5mmの5.0～9.5%カルボニル鉄ゴムを用いている。図において黒丸印のAは、強誘電体層3として0.5mmのチタン酸バリウムの焼結体を用いて構成された電波吸収体の反射減衰量を示したものである。計算結果と同様9.0MHzにおいて、2.9dBの反射減衰量が得られており、UHF帯において厚さ2mmの電波吸収体を実現することが可能となった。実線Bは樹脂分散材0.5mmの場合、白丸印Cは強誘電体層3が無い場合の特性である。なお、軟磁性体層2としては、5.0～9.5%カルボニル鉄ゴムとチタン酸バリウム焼結体でも良いし、あるいはその樹脂分散材でも良

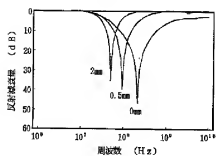
【図3】



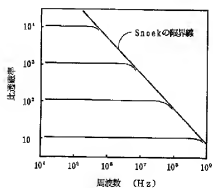
【図4】



【図5】



【図6】



【図8】

